Claims

What is claimed is:

[c1] A method for manufacturing an optical device, comprising:

coating a substrate with a resin thin layer, wherein temperature of the resin thin layer is controlled lower than a polymerization reaction starting temperature thereof and the resin is not substantially polymerized;

heating the resin thin layer to a temperature higher than polymerization reaction starting temperature and glass-transition temperature but lower than a thermal decomposition starting temperature of the resin so that the resin thin layer is polymerized on the substrate to form a resin thin film thereon;

pressing a stamp having an inverted micro-asperity pattern against the resin thin film such that a micro-asperity pattern is formed on a surface of the resin thin film;

cooling the resin thin film to a temperature lower than the glass-transition temperature; and

separating the stamp from the resin thin film.

[c2] The method according to claim 1, wherein the stamp is pressed against the resin thin film a plurality of times.

[c3] The method according to claim 1, wherein the substrate is provided with an alignment mark thereon such that the stamp can be placed on the substrate in a manner that the alignment mark provided on the substrate matches a reference position of the stamp.

[c4] The method according to claim 1, wherein the micro-asperity pattern is formed on the surface of the resin thin film in an inert gas atmosphere.

[c5] The method according to claim 1, wherein the micro-asperity pattern is formed on the surface of the resin thin film in a chamber, and pressure inside the chamber is maintained lower than atmospheric pressure.

[c6] A method for manufacturing an optical device, comprising:

coating a substrate with a resin thin layer, wherein temperature of the resin thin layer is controlled lower than a polymerization reaction starting temperature thereof and the resin is not substantially polymerized;

pressing a stamp having an inverted micro-asperity pattern against the resin thin layer and separating the stamp from the resin thin layer such that a micro-asperity pattern is formed on a surface of the resin thin layer; and

heating the resin thin layer to a temperature higher than polymerization reaction starting temperature but lower than a glass-transition temperature of the resin such that the resin thin layer is polymerized to form a resin thin film having the micro-asperity pattern thereon.

[c7] The method according to claim 6, wherein the stamp is pressed against the resin thin layer a plurality of times.

[c8] The method according to claim 6, wherein the substrate is provided with an alignment mark thereon such that the stamp can be placed on the substrate in a manner that the alignment mark provided on the substrate matches a reference position of the stamp.

[c9] The method according to claim 6, wherein the micro-asperity pattern is formed on the surface of the resin thin film in an inert gas atmosphere.

[c10] The method according to claim 6, wherein the micro-asperity pattern is formed on the surface of the resin thin film in a chamber, and pressure inside the chamber is maintained lower than atmospheric pressure.

[c11] An apparatus for manufacturing an optical device, comprising:

a stamp comprising a micro-asperity pattern;

a pressurizing mechanism attached to the stamp for pressing the stamp downward;

a transfer stage disposed under the stamp for holding a substrate thereon, wherein the substrate is coated with a resin thin film;

a heating means attached to the transfer stage for heating the resin thin film on the substrate; and

a transfer stage transfer direction moving mechanism for moving the transfer stage;

wherein upon pressing the stamp downward by the pressurizing mechanism, a micro-asperity pattern is formed on a surface of the resin thin film.

[c12] The apparatus according to claim 11, further comprising a pressurizing mechanism transfer direction moving mechanism attached to the pressurizing mechanism for moving the pressurizing mechanism.

[c13] The apparatus according to claim 11, wherein the stamp comprises a heating means.

[c14] The manufacturing apparatus according to claim 12, wherein the stamp comprises a heating means.

[c15] The apparatus according to claim 11, wherein the apparatus is configured in such a manner that the substrate is disposed under the stamp so as to be able to move in an X direction and a Y direction and rotate about a Z axis, whereby a position of the substrate can be adjusted with respect to the stamp.

[c16] The apparatus according to claim 12, wherein the apparatus is configured in such a manner that the substrate is disposed under the stamp so as to be able to move in an X direction and a Y direction and rotate about a Z axis, whereby a position of the substrate can be adjusted with respect to the stamp.

[c17] The apparatus according to claim 11, wherein the stamp has a cylindrical shape in which an outer circumferential surface is formed with the inverted micro-asperity pattern, and wherein the micro-asperity pattern is formed on the surface of the resin thin film as the die rolls on the surface of the resin thin film while being pressed against the resin thin film.

[c18] The apparatus according to claim 12, wherein the stamp has a cylindrical shape in which an outer circumferential surface is formed with the inverted micro-asperity pattern, and wherein the micro-asperity pattern is formed on the surface of the resin thin film as the stamp rolls on the surface of the resin thin film while being pressed against the resin thin film.

[c19] The apparatus according to claim 11, further comprising a transfer stage crossing direction moving mechanism for moving the transfer stage in a crossing direction that crosses a micro-asperity pattern transfer direction, whereby a relative movement can be caused between the resin thin film and the stamp in each of the micro-asperity pattern transfer direction and the crossing direction.

[c20] The apparatus according to claim 12, further comprising a transfer stage crossing direction moving mechanism for moving the transfer stage in a crossing direction that crosses a micro-asperity pattern transfer direction, whereby a relative movement can be caused between the resin thin film and the stamp in each of the micro-asperity pattern transfer direction and the crossing direction.

[c21] The apparatus according to claim 11, wherein the stamp comprises a stamper to be pressed against the resin thin film to form the micro-asperity pattern on the surface thereof, a base for holding the stamper, and an elastic member interposed between the stamper and the base.

[c22] The apparatus according to claim 12, wherein the stamp comprises a stamper to be pressed against the resin thin film to form the micro-asperity pattern on the surface thereof, a base for holding the stamper, and an elastic member interposed between the stamper and the base.

[c23] The apparatus according to claim 11, wherein the stamp comprises an embossment roll member to be pressed against the resin thin film to form the micro-asperity pattern on the surface thereof, a roll body for holding the embossment roll member, and an elastic member interposed between the embossment roll member and the roll body.

[c24] The apparatus according to claim 12, wherein the stamp comprises an embossment roll member to be pressed against the resin thin film to form the micro-asperity pattern on the surface thereof, a roll body for holding the embossment roll member, and an elastic member interposed between the embossment roll member and the roll body.

[c25] The apparatus according to claim 11, wherein the pressurizing mechanism comprises at least one alignment mark observation optical device so that at least one alignment mark provided on the substrate can be recognized visually.

[c26] The apparatus according to claim 12, wherein the pressurizing mechanism comprises at least one alignment mark observation optical device so that at least one alignment mark provided on the substrate can be recognized visually.

[c27] The apparatus according to claim 11, further comprising at least one alignment mark observation optical device that is disposed under the substrate so that at least one pair of a first alignment mark provided on the substrate and a second alignment mark provided on the stamp can be recognized visually.

[c28] The apparatus according to claim 12, further comprising at least one alignment mark observation optical device that is disposed under the substrate so that at least one pair of a first alignment mark provided on the substrate and a second alignment mark provided on the stamp can be recognized visually.

[c29] An apparatus for manufacturing an optical device, comprising:

a transfer stage for holding a substrate that is coated with a resin thin film;

a stamp having an inverted micro-asperity pattern;

a pressurizing mechanism for pressing the die against the resin thin film at a prescribed position;

a moving mechanism for moving one of the transfer stage and the die while the stamp is pressed against the resin thin film;

a heating means for heating the substrate;

an airtight chamber for accommodating at least the transfer stage, the die, the pressurizing mechanism, the moving mechanism, and the heating means; and

exhausting means for exhausting a gas from the airtight chamber prior to an operation that a micro-asperity pattern is formed on a surface of the resin thin film by pressing the die against the resin thin film.

[c30] A method for manufacturing a reflection plate, comprising:

coating a substrate with a resin thin layer, wherein temperature of the resin thin layer is controlled lower than a polymerization reaction starting temperature and the resin is not substantially polymerized;

heating the resin thin layer to a temperature higher than polymerization starting temperature and glass-transition temperature but lower than a thermal decomposition starting temperature of the resin so that the resin thin layer is polymerized on the substrate to form a resin thin film;

pressing a stamp having an inverted micro-asperity pattern against the resin thin film such that a micro-asperity pattern is formed on a surface of the resin thin film;

cooling the resin thin film to a temperature lower than the glass-transition temperature;

separating the stamp from the resin thin film; and

forming a reflection film and an alignment film on the resin film having the micro-asperity pattern thereon.

[c31] A method for manufacturing a reflection plate, comprising:

coating a substrate with a resin thin layer in which polymerization reaction has not occurred yet substantially;

controlling a temperature of the resin thin film to a temperature that is lower than a polymerization reaction starting temperature of the resin thin film;

pressing a stamp having an inverted micro-asperity pattern against the resin thin film in a state that the temperature of the resin thin film is controlled so as to be lower than the polymerization reaction starting temperature;

separating the stamp from the resin thin film;

heating the resin thin film so that the temperature of the resin thin film becomes higher than the polymerization reaction starting temperature and lower than a glass-transition temperature of the resin thin film, whereby a micro-asperity pattern is formed on a surface of the resin thin film; and

forming a reflection film and an alignment film on the resin film having a micro-asperity pattern thereon.